Project eems043
Mobility Decision Science pillar

U.S. DEPARTMENT OF ENERGY

SMARTMOBILITY

Systems and Modeling for Accelerated Research in Transportation

Mobility Behavioral Responses to Transportation Network Companies

ALEJANDRO HENAO (NREL), TOM WENZEL (BERKELEY LAB)

2019 Vehicle Technologies Office Annual Merit Review

June 11, 2019

Argonne NATIONAL LABORATORY

INL Idaho National Laboratory

BERKELEY LAB

OAK RIDGE National Laboratory

NREL NATIONAL RENEWABLE ENERGY LABORATORY

OVERVIEW

Timeline

- Project start date: Aug 2017
- Project end date: Sept 2019
- Percent complete: 75%

Barriers

- Limited data to understand whether rapidly expanding transportation network company (TNC) services result in net decrease or increase in energy use

Budget

- Total project funding: $834K
  - FY 2017: $300K
  - FY 2018: $300K
  - FY 2019: $234K

Partners

- National Renewable Energy Laboratory (NREL)
- Lawrence Berkeley National Laboratory (Berkeley Lab)
- Carnegie Mellon University

PROJECT RELEVANCE

ENERGY EFFICIENT MOBILITY SYSTEMS

VISION

An affordable, efficient, safe, and accessible transportation future in which mobility is decoupled from energy consumption.

ENERGY EFFICIENT MOBILITY SYSTEMS

MISSION

The EEMS Program conducts early-stage R&D at the vehicle, traveler, and system levels, creating new knowledge, tools, insights, and technology solutions that increase mobility energy productivity for individuals and businesses.

- This task supports the Energy Efficient Mobility Systems (EEMS) vision and mission by developing new techniques and sharing research insights that help identify and understand the most important levers to improve the energy productivity of emerging mobility systems such as TNCs.

PROJECT RELEVANCE

Objective: Determine the impacts (and scale) of TNC services on mobility behavior and energy use.

Several travel and energy implications (short- to long-term):

- Number and length of trips (vehicle miles traveled)
- Deadheading (empty miles)
- Ride-sharing behavior
- Modal shift
- Vehicle type (fuel efficiency, electric vehicles [EVs])
- Household vehicle ownership

MILESTONES

Date	Milestone	Status
FY18 Q4	Draft report on TNCs and vehicle registration analysis of urban areas Draft report on net energy impact of TNCs in Austin, Texas	Complete
FY19 Q2	Journal publication on travel and energy implications of TNCs in Austin, Texas	Complete
FY19 Q3–Q4	Report/publication on energy aspects of TNCs, and vehicle registration analysis	On Track

APPROACH

- Identify and investigate mobility and energy impacts of TNCs
- Understand data needs, including availability
- Research Question 1: What are the main TNC factors impacting energy use?
  - Ongoing literature review, data collection, and analysis on TNCs to better understand main factors contributing to mobility and energy impacts
- Research Question 2: What is the estimated net energy impact (including vehicle efficiency, deadheading, modal shift, and sharing rides) of TNCs?
  - Analysis of 1.5 million rides from RideAustin (TNC in Austin, Texas)
- Research Question 3: What is the national impact of TNC availability on vehicle ownership?
  - Regression analysis using a difference-in-difference econometric model with vehicle registration (Polk) data, TNC-entry dates, and census data (e.g., demographics, economics, travel modes)
- Synergy with US 2.1.1: Ground transportation at airports

TECHNICAL ACCOMPLISHMENTS AND PROGRESS
Research Question 1: Main TNC Factors Impacting Energy Use

MACRO

MICRO

VEHICLE TYPE: Are vehicles used for TNCs more fuel efficient (including EVs)?

MODE SHIFT (LONG RANGE): Over time, are people starting to use transit, biking, and walking more frequently or less frequently? (Vehicle ownership)

QUANTITY OF TRAVEL: Induced or reduced travel (Number and length of trips)

MODE SHIFT (SHORT RANGE): Substitution of TNCs for specific, recent trips

POOLING: To what extent are trips being pooled? Are these trips that would have (short- and long-run) been made by transit or by a personal vehicle?

DEADHEADING: How many empty miles are being driven?

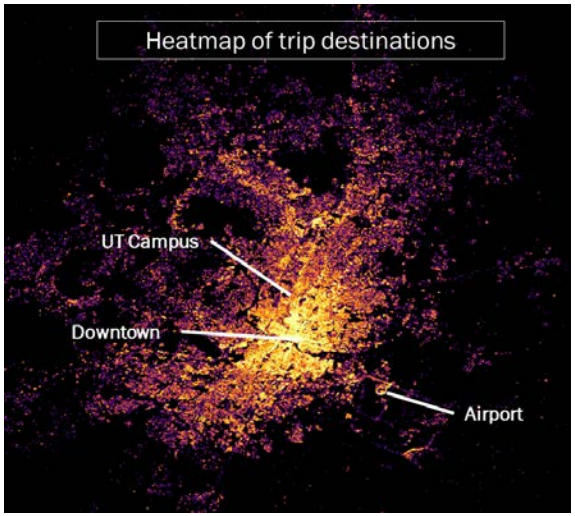
SPATIAL AND TIME OF DAY VARIATION

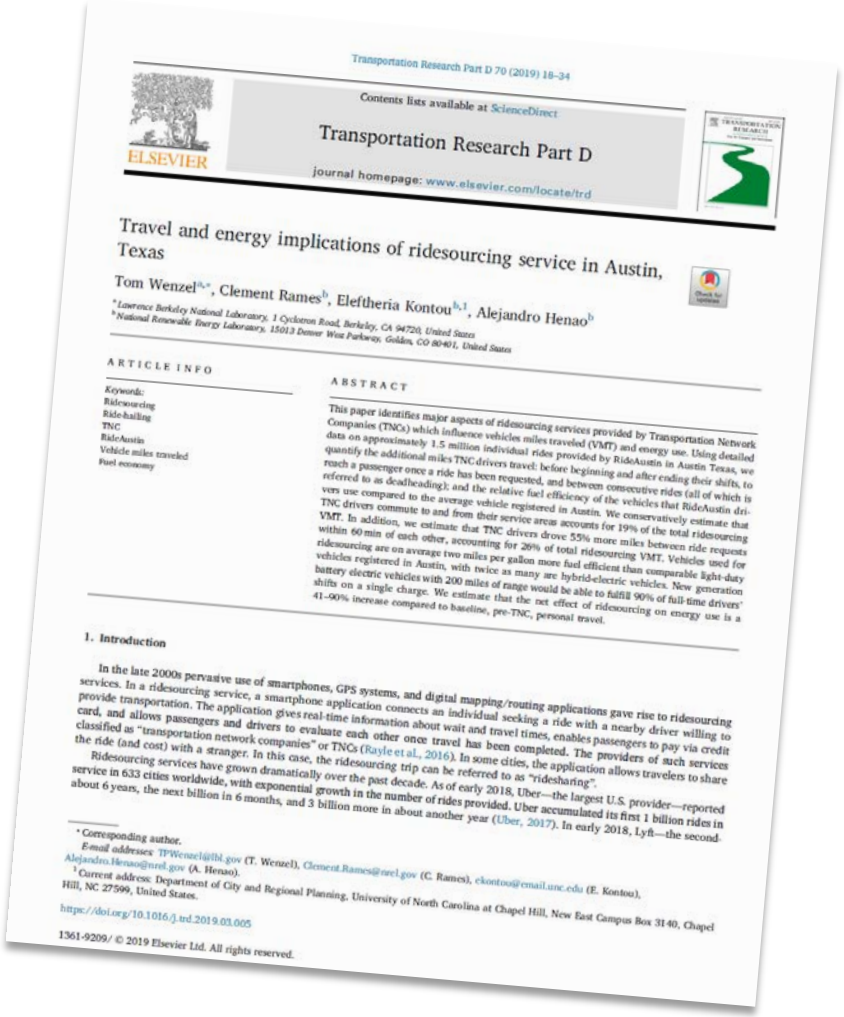
OTHER FACTORS: Operations (e.g., supply versus demand, location of drivers), driving behavior, relocation and travel decisions, infrastructure, traffic impacts, parking, pick-ups/drop-offs, other indirect effects

TECHNICAL ACCOMPLISHMENTS AND PROGRESS
Research Question 2: RideAustin Analysis

Travel and energy implications of a TNC in Austin, Texas:

- Commute deadheading
- Between-ride deadheading
- Vehicle efficiency
- Modal shift and sharing rides (estimated from literature)





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Travel and energy implications of ridesourcing service in Austin, Texas

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ABSTRACT

This paper identifies major aspects of ridesourcing services provided by Transportation Network Companies (TNCs) which influence vehicles miles traveled (VMT) and energy use. Using detailed data on approximately 1.5 million individual rides provided by RideAustin in Austin Texas, we quantify the additional miles TNC drivers travel: before beginning and after ending their shifts, to reach a passenger once a ride has been requested, and between consecutive rides (all of which is referred to as deadheading); and the relative fuel efficiency of the vehicles that RideAustin drivers use compared to the average vehicle registered in Austin. We conservatively estimate that TNC drivers commute to and from their service areas accounts for 19% of the total ridesourcing VMT. In addition, we estimate that TNC drivers drove 55% more miles between ride requests within 60 min of each other, accounting for 26% of total ridesourcing VMT. Vehicles used for ridesourcing are on average two miles per gallon more fuel efficient than comparable light-duty vehicles registered in Austin, with twice as many are hybrid-electric vehicles. New generation battery electric vehicles with 200 miles of range would be able to fulfill 90% of full-time drivers' shifts on a single charge. We estimate that the net effect of ridesourcing on energy use is a 41–90% increase compared to baseline, pre-TNC, personal travel.

1. Introduction

In the late 2000s pervasive use of smartphones, GPS systems, and digital mapping/routing applications gave rise to ridesourcing services. In a ridesourcing service, a smartphone application connects an individual seeking a ride with a nearby driver willing to provide transportation. The application gives real-time information about wait and travel times, enables passengers to pay via credit card, and allows passengers and drivers to evaluate each other once travel has been completed. The providers of such services classified as "transportation network companies" or TNCs (Rayle et al., 2016). In some cities, the application allows travelers to share the ride (and cost) with a stranger. In this case, the ridesourcing trip can be referred to as "ridesharing".

Ridesourcing services have grown dramatically over the past decade. As of early 2018, Uber—the largest U.S. provider—reported service in 633 cities worldwide, with exponential growth in the number of rides provided. Uber accumulated its first 1 billion rides in about 6 years, the next billion in 6 months, and 3 billion more in about another year (Uber, 2017). In early 2018, Lyft—the second-

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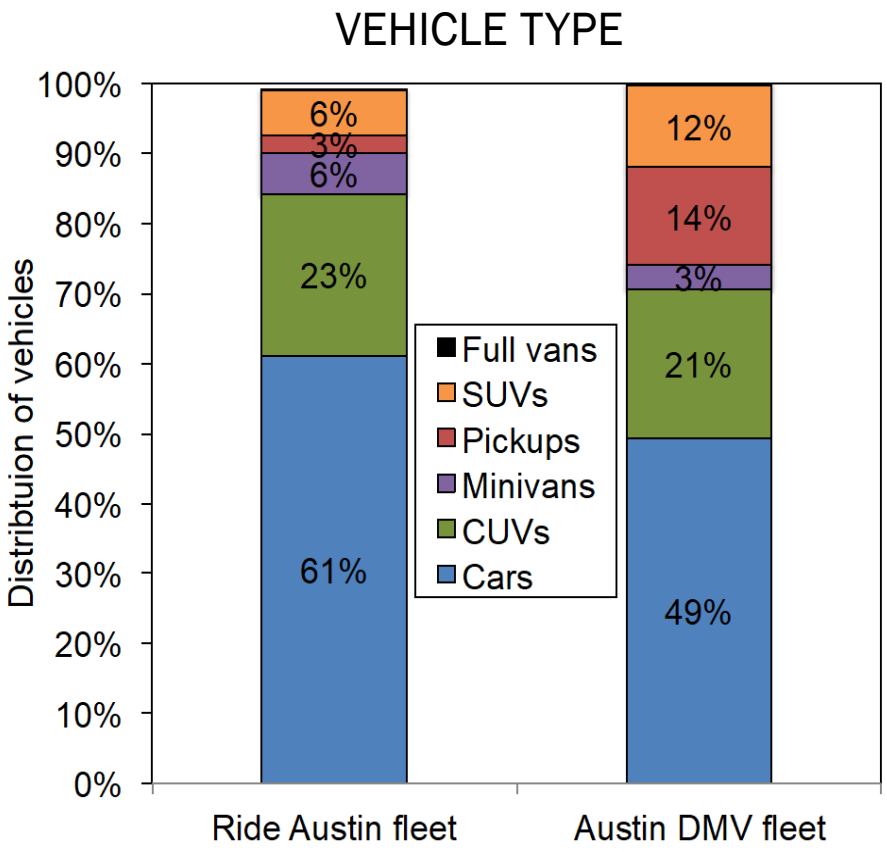
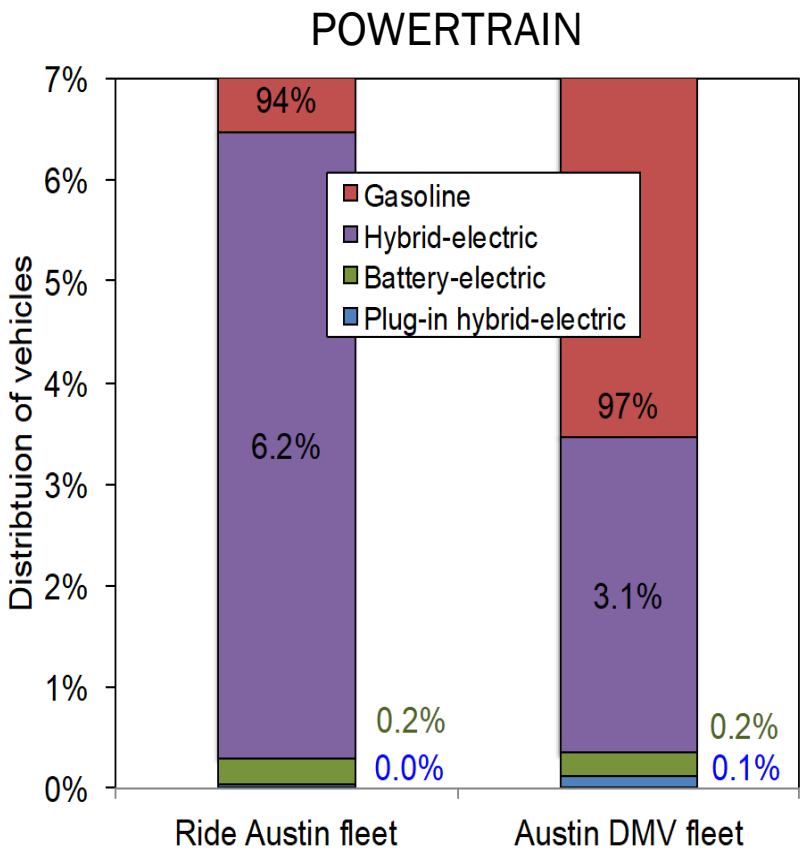
TECHNICAL ACCOMPLISHMENTS AND PROGRESS
Research Question 2: RideAustin Analysis

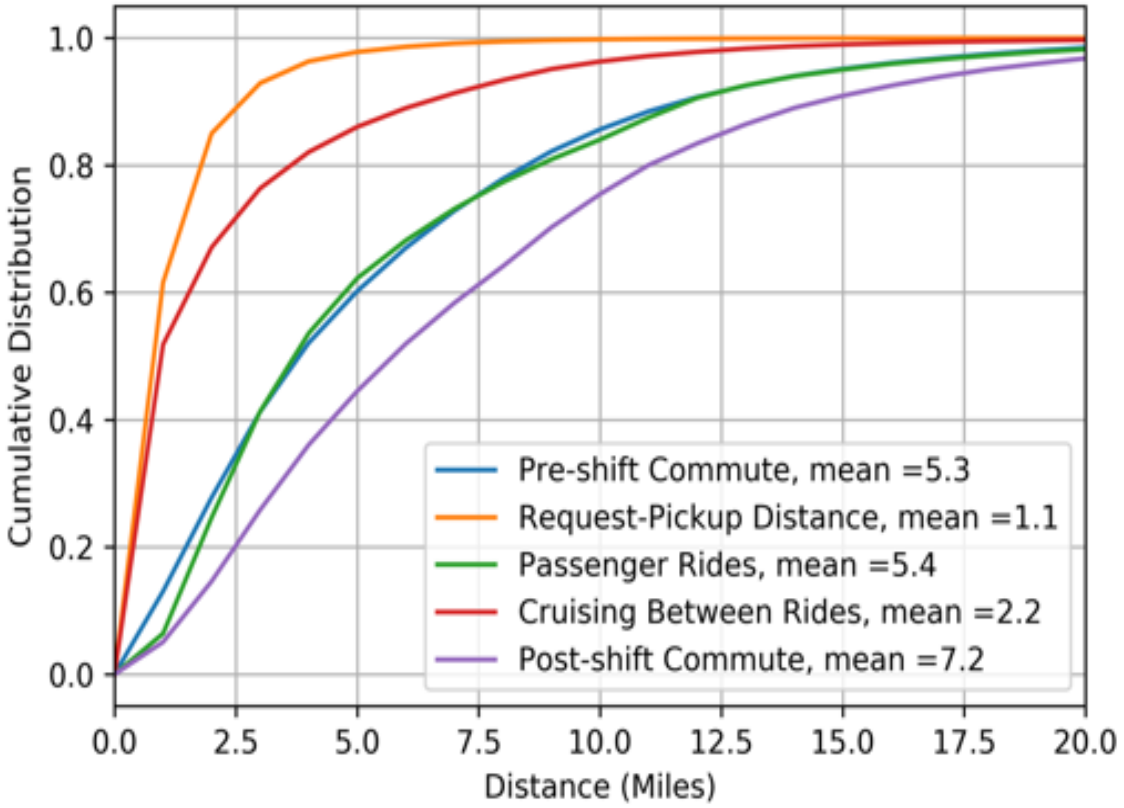




- In Austin, Texas, vehicles used in TNC service are newer and, overall, 3.2 MPG more efficient than the average vehicle in Austin

TECHNICAL ACCOMPLISHMENTS AND PROGRESS
Research Question 2: RideAustin Analysis

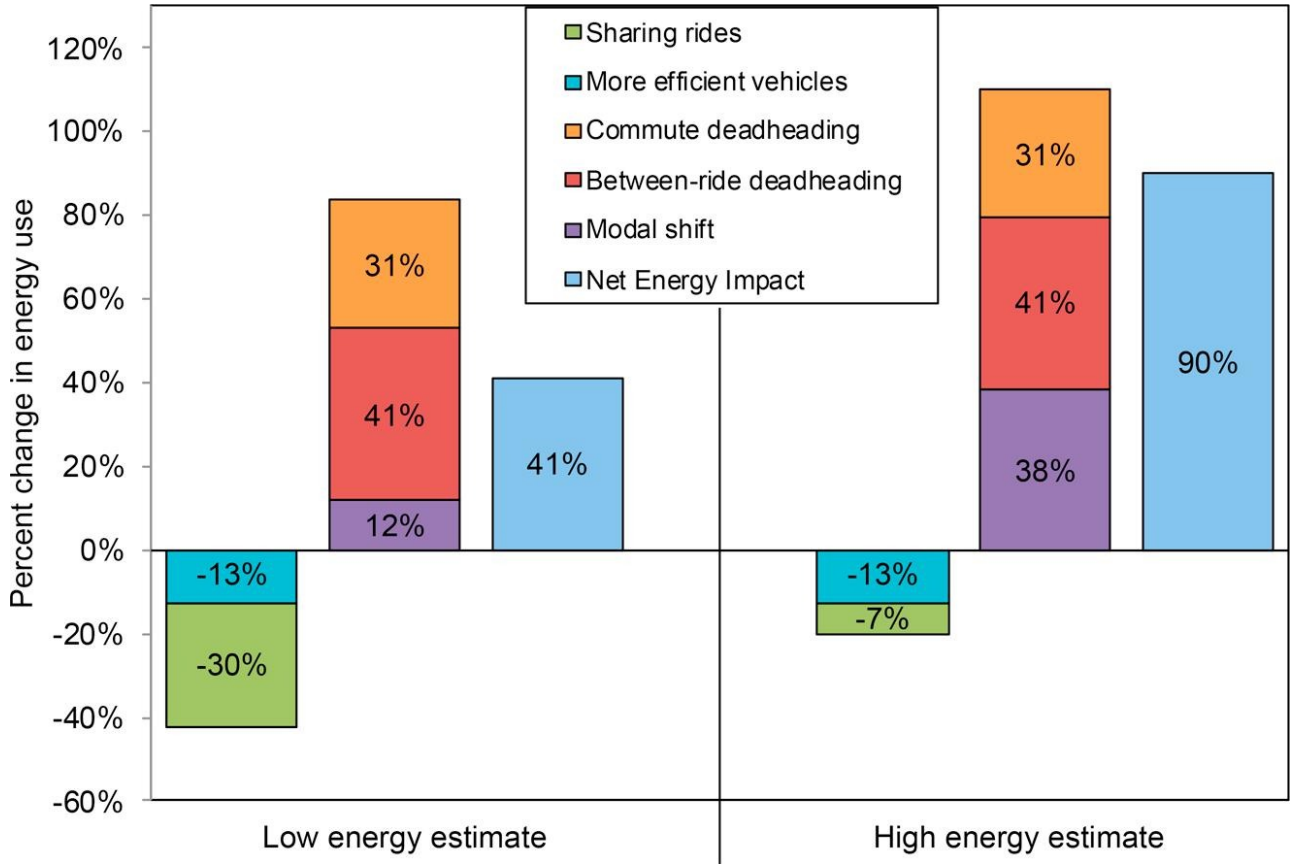
- One-way commute distance is as long as one TNC ride
- Distance to reach rider is on average 20% of each ride
- Distance cruising between rides is on average 50% of each ride
- Commuting is 19%, and between-ride deadheading is 26% of total vehicle miles traveled (VMT)



TECHNICAL ACCOMPLISHMENTS AND PROGRESS
Research Question 2: RideAustin Analysis

Net energy estimates:

- TNCs increase energy use by an estimated 41%–90% compared to the prior mode.
- The magnitude of negative effects for energy use (deadheading and mode shifts) outweighs positive effects (vehicle efficiency and sharing rides potential).



TECHNICAL ACCOMPLISHMENTS AND PROGRESS
Research Question 3: TNC and Vehicle Ownership

Research Question

How are TNCs changing American cities in terms of vehicle ownership, electric vehicle adoption, and transit use?

Available Data

Combine IHS/Polk (vehicle registration) and Census data (socio-demographic covariates)

Polk vehicle registrations by:

- Urban areas
  (1,265, ~50% with TNC service by 2017)
- ZIP codes
  (30,000+, ~20% in TNC service areas)

Modeling Approach

Difference-in-difference regression model with geographic and year fixed effects

$$y_{ct} = \boldsymbol{\beta}'\mathbf{x}_{ct} + \boldsymbol{\alpha}'\mathbf{z} + \gamma_c + \delta_t + \phi_c t + \varepsilon_{ct}$$

Dependent variables:
- Vehicle registrations
- Electric vehicle adoption
- Transit ridership

Treatment:
- TNC entry

Control variables:
- Population
- Population density
- Unemployment
- Income
- Transit commuting (%)
- Households with children (%)
- Population under 16 and over 65

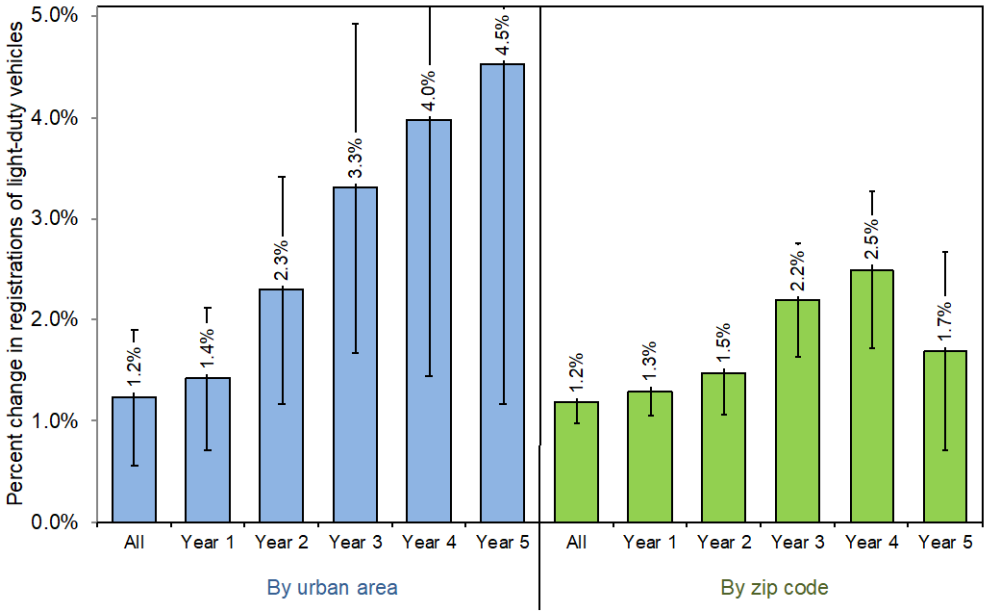
Fixed effects:
- City *c*
- Year *t*

Unobserved error

TECHNICAL ACCOMPLISHMENTS AND PROGRESS
Research Question 3: TNC and Vehicle Ownership

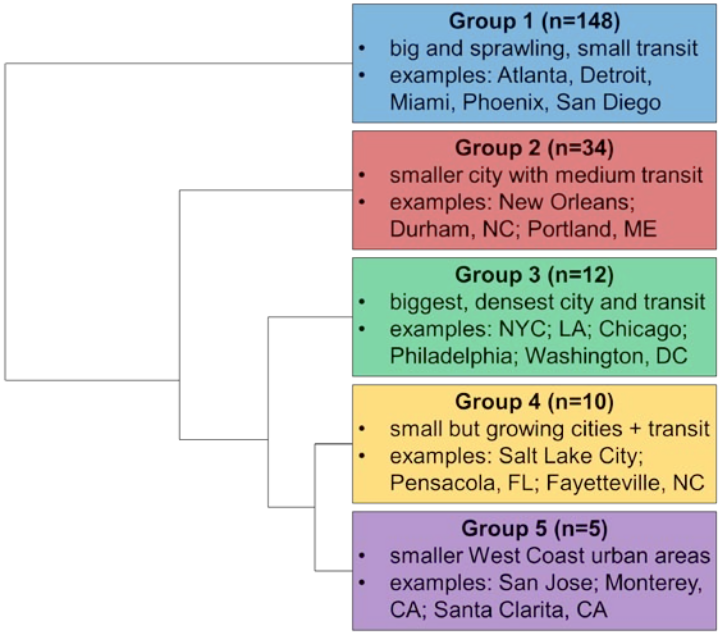
Preliminary:

On average, TNC entry associated with net <u>increase</u> in registrations

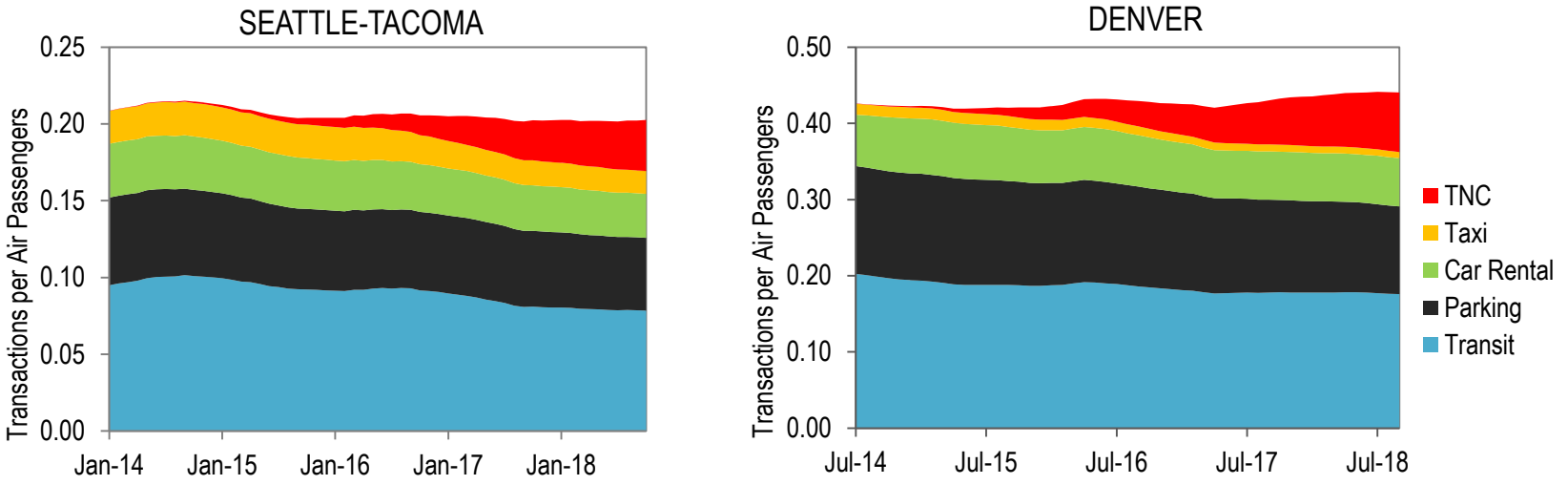


Next Step:

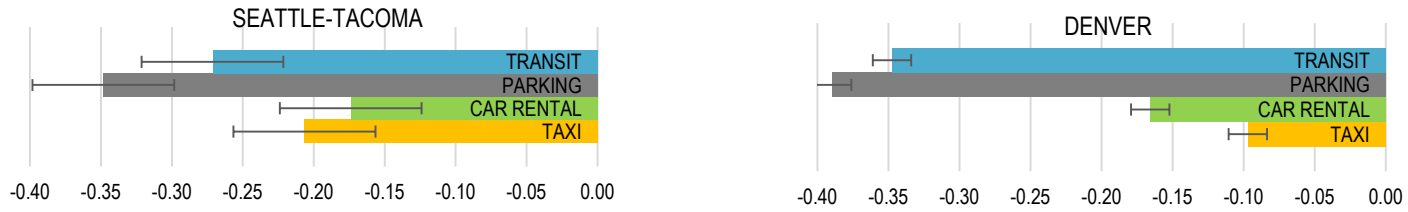
Clustering analysis will explore effect heterogeneity across urban area types



SYNERGY WITH US 2.1.1: GROUND TRANSPORTATION AT AIRPORTS



DECREASE IN GROUND TRANSPORTATION TRANSACTIONS PER UNIT OF TNC INCREASE



RESPONSES TO PREVIOUS YEAR'S REVIEWERS COMMENTS

- Concerns around analyzing correlations and implying causations
  - Difficult to tease out opposing effects
  - Causal inference is constrained by the application and underlying assumptions of appropriate models (i.e., difference-in-difference and propensity weighting)

- Additional worthwhile research questions to address
  - Continue to define specific research questions
  - Data collection is critical
  - Funding needs

COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS

NREL	**NREL** • Data gathering, cleansing, analysis • Experience with TNC data collection and analysis
BERKELEY LAB	**Berkeley Lab** • Data gathering, cleansing, analysis • Experience with TNC and regression analysis
University	**Carnegie Mellon University** • Data gathering, cleansing, analysis • Doctoral student—TNC research
Industry Collaboration	**Research team requested entry dates to TNCs:** • Uber provided list of UberX entry at some cities • Lyft provided list • Other research collaborations (in development)

REMAINING CHALLENGES AND BARRIERS

- Data availability and sharing
  - Polk registration data by year and model at zip code level
  - Individual TNC ride data (requires cooperation of TNCs)
  - Driver (commuting, vehicle purchase) and rider (pooling, mode shift) behavior (requires surveys of drivers/riders)
- Difficult to tease out opposing effects
  - TNC entry can increase ownership for TNC drivers, but decrease ownership for riders
- Causal inference is constrained by the application and underlying assumptions of appropriate models (i.e., difference-in-difference and propensity weighting)

PROPOSED FUTURE RESEARCH

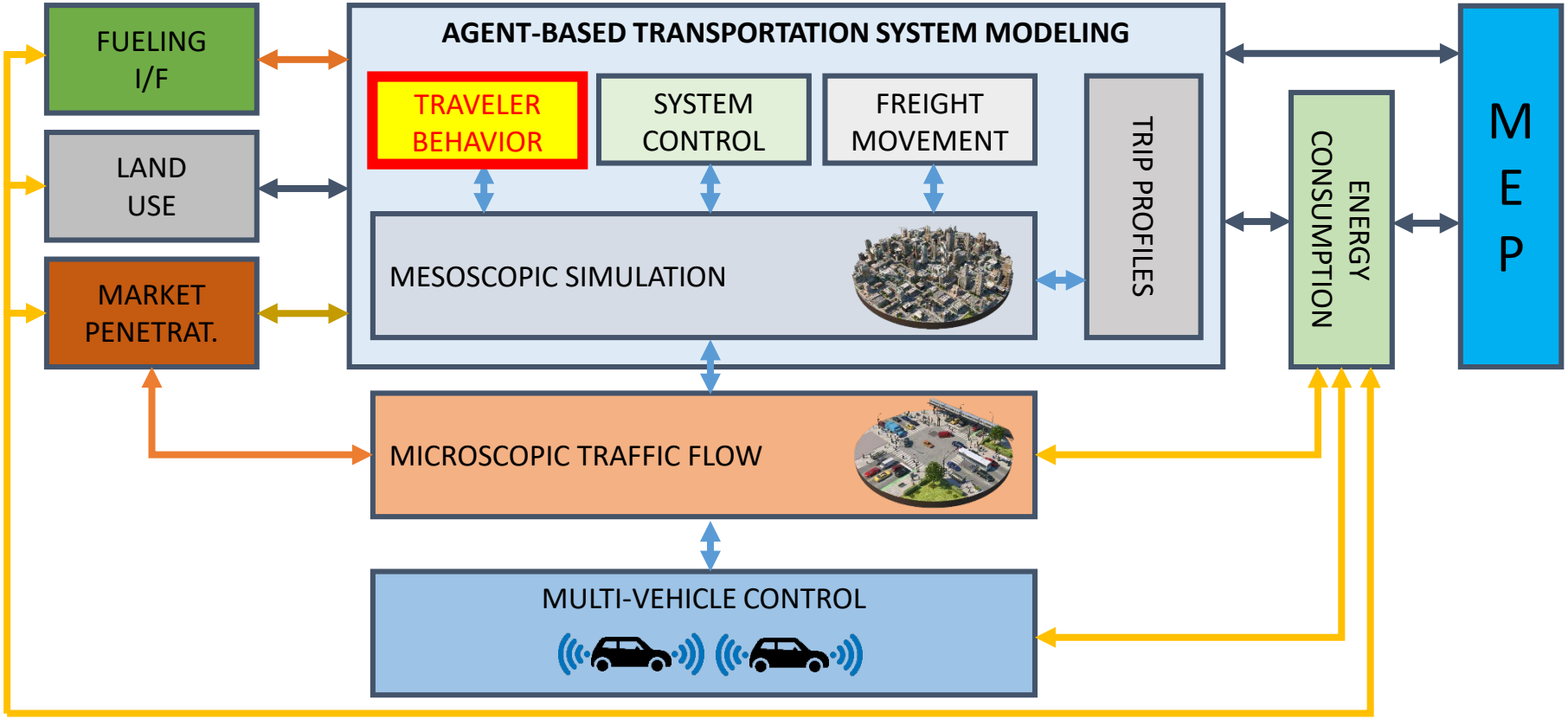
- Research Question 1 and 2:
  - Identify additional TNC data gaps and continue data collection and analysis to better understand how mobility behavior changes induced by TNCs impact energy use
- Research Question 3:
  - Use individual vehicle-level VMT to assess effect of TNC entry on registrations, sales, and annual VMT for specific states where data is available (e.g., Texas and Pennsylvania)
- Data collection is critical

[Note: Any proposed future work is subject to change based on funding levels]

SUMMARY

- There are limited data sources and research to understand the energy implications of TNCs.
- This task is gathering data and conducting analysis related to TNCs from a variety of sources.
- A case study in Austin, Texas, shows that TNCs increase energy use by an estimated 41%–90% compared to the prior mode. The magnitude of negative effects for energy use (deadheading and mode shifts) outweighs positive effects (vehicle efficiency and sharing rides potential).
- TNCs have heterogeneous effects on vehicle ownership and transit use.

END-TO-END MODELING WORKFLOW



THANK YOU!
QUESTIONS?

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